FREE-AIR SUMMARY.

By L. T. SAMUELS, Meteorologist.

The outstanding feature of the month was the prevalence of positive temperature departures, particularly in the middle and lower latitudes of the country. (See Table 1.) The departures found at the aerological stations conformed in amount closely with those shown in climatological Chart III. At every station except Ellendale and Groesbeck the departures fell off appreciably in amount with increase in altitude, becoming in some cases negative in the highest levels. At Ellendale they increased slightly in amount with increasing altitude. At this station, however, the departures in the lower levels were exceedingly small. At Groesbeck, the southernmost station, large positive departures persisted to 5,000 m.

Maximum temperature records were broken during the month for various levels at Broken Arrow, Ellendale, and Groesbeck. On these days there was usually found a large temperature inversion, its influence extending to heights between 2,000 m. and 3,000 m. where the temperature was higher even than that at the surface.

Mean relative humidities for the month were mostly below normal, exceptions being found in the lower levels at Ellendale, the upper levels at Groesbeck, and all levels at Royal Center. Notwithstanding the wide fluctuations found in this element on individual days, the monthly means differ comparatively little from the normal values as shown in the table.

Mean vapor pressures varied only slightly from the monthly normals, the departures being in general positive at those stations having the greatest positive temperature departures and negative elsewhere. At Groesbeck, where positive temperature departures persisted at all levels, the vapor pressure departures were greatest and all positive.

Atmospheric electric potentials, markedly higher than normal, were observed on 8 of the first 10 days of the month at Groesbeck, Tex.

In Table 2 are shown the resultant wind velocities and directions for the month and their normal values, the latter being based on the period indicated for each station in the heading of the table. These resultants show rather unique characteristics for the various stations. In the lower levels at Broken Arrow where the south component is strongly marked the resultant velocity exceeds its normal appreciably, thus conforming with the large positive temperature departures found at this station in these levels. At Drexel the normal amount of the north component was only slightly less pronounced in the lower levels in the resultant for the month. In the higher levels, however, there is a considerable shift to the southward. This latter fact is likewise true at the other two northern stations and is mentioned in connection with the statement by E. H. Bowie appearing in this REVIEW under the section of "Weather and storm warnings," to the effect that the paths of the anticyclones were generally in relatively high latitudes and the cold waves of the month for this reason were confined to the more northern sections of the United States. Due West shows very little difference between the resultant for the month and the averages. The period of record here, however, is too short to permit strict comparison. In comparing the monthly means and normals at Ellendale there is found in the lower levels a greater north component for the month, while in the upper levels a smaller one occurred. This fact is in harmony with the temperature departures shown in Table 1. At Groesbeck the south component very decidedly exceeded the normal direction as well as the resultant velocity for the month. This was most pronounced in the lower levels, conforming remarkably with the consistent positive temperature departures at this station. Practically no difference is found between the resultant and normal winds at Royal Center where temperature departures were comparatively small.

Upper winds of hurricane velocity prevailed frequently over some sections of the country. At Drexel for the two-week period (7th–20th) these strong winds continually beat down the kites and prevented the reaching of high altitudes. Similar winds were general above Due West during the week ending the 13th and above Royal Center at frequent intervals throughout the month, causing the kites to beat down.

Following is a list of the stations reporting velocities of 40 m. p. s. or higher occurring during the month:

Station.	Date.	Velocity.	Direction.	Altitude.
		m. p. s.		*m.*
Broken Arrow, Okla.	10	40	NW.	10,200
Do.	12	51	W.	7,500
Do.	16	42	NW.	7,900
Drexel, Nebr.	15	50	NW.	4,000
Due West, S. C.	5	40	W.	7,300
Do.	10	46	WNW.	4,000
Do.	16	80	WNW.	6,400
Ellendale, N. Dak.	21	42	NNW.	4,500
Groesbeck, Tex.	2	46	WNW.	2,800
Mitchel Field, N. Y.	18	42	SW.	2,700

The extraordinary velocity of 80 m. p. s. reported from Due West on the morning of the 16th demands careful *consideration before being accepted as correct.* That high velocities were general over this region at this time is shown by the following reports from surrounding stations:

Station.	Velocity.	Direction.	Altitude.
	M.p.s.		*M.*
Fort Bragg, N. C.	35	WNW.	4,500
Fort Benning, Ga.	34	NW.	3,000
Camp Custis, Va.	32	NW.	4,000

Furthermore, the afternoon observation at Due West showed a velocity of 43 m. p. s. from NW. at 2,500 m. A two-theodolite run started immediately after the first observation proved unsuccessful, however, when the balloon was lost to view from one of the observing stations. The weather map on this date shows this region to have been under the influence of a high pressure area central over Texas, with a deep area of low barometer off the Gulf of St. Lawrence. The 2,000 m. pressure map as drawn from surface observations by the method de-

scribed in MONTHLY WEATHER REVIEW SUPPLEMENT No. 21 indicates the persistence of this pressure distribution to this height, and pilot balloon observations at numerous stations on this date clearly showed the same gradient with high velocities to 4,000 m., the maximum of the observations.

The following note by the observer at Royal Center describes an interesting phenomenon observed at that station on the 15th:

During the second flight of a series on January 15 a peculiar cloud formation was observed about 1:15 p. m. The predominating clouds at that time were 5 ASt from the West with here and there a detached portion of StCu from the Northwest. As a group of three of the broken StCu floated past the reel shelter it was noted that each had a fringe cloud hanging from underneath similar in appearance and structure to the down streamers of a summer rain cloud. The streamers, however, were not as dark colored as those of a rain cloud. No precipitation had occurred at any time during the day and none occurred during the remainder of the day. The upper parts of the clouds were broken into small portions resembling ACu which were apparently carried along with the main body of the cloud and retained their relative positions to them. Interwoven among the small clouds were wisps of other clouds having the appearance of smoke streamers or false cirrus. These also floated along with the StCu cloud. The wind velocity at an altitude of 1,000 meters, probably about the height of the StCu cloud was 20 m. p. s., as shown by the pilot balloon observation at 2 p. m. These clouds retained their peculiar formation until they passed out of sight in an easterly direction.

It is presumed that the phenomenon described was falling snow, evaporating before reaching the earth. The kite record made during this time shows a sharp decrease in the relative humidity (from 90 to 37 per cent) of the air immediately below this cloud layer. This dryness would aid evaporation. The fact that snow flurries occurred the next morning seems of further significance.

Easterly winds above 4,000 m., which at this season of the year are rare, were reported as follows:

Station.	Altitude.	Direction.	Velocity.	Date.
	M.		*M.p.s.*	
Camp Lewis, Wash.	8,400	e.	5	20
Do	6,200	nne.	16	24
Do	6,400	nne.	12	29
Crissy Field, Calif.	4,000	ne.	13	31
Fort Riley, Kans.	4,000	ese.	4	22
Groesbeck, Tex.	4,000	nne.	5	16
Key West, Fla.	4,400	nne.	4	22
Do	5,300	nne.	4	26
Do	9,000	e.	3	29
Do	9,000	ne.	24	31
Royal Center, Ind.	4,700	sse.	11	23
San Francisco, Calif.	4,200	nne.	26	31

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during January, 1923.*

TEMPERATURE (°C.).

Altitude, m. s. l. (*m.*)	Broken Arrow, Okla. (233*m.*)		Drexel, Nebr (396*m.*)		Due West, S. C. (217*m.*)		Ellendale, N. Dak. (444*m.*)		Groesbeck, Tex. (141*m.*)		Royal Center, Ind. (225*m.*)	
	Mean	Departure from 5-year mean.	Mean	Departure from 8-year mean.	Mean	Departure from 2-year mean.	Mean	Departure from 6-year mean.	Mean	Departure from 5-year mean.	Mean	Departure from 5-year mean.
Surface	9.4	+4.4	−1.8	+3.8	9.1	+1.5	−10.0	+0.4	13.1	+4.0	−1.7	+1.6
250	9.3	+4.3	.....	.....	9.0	+1.5	.....	.....	13.0	+4.3	−1.9	+1.5
500	8.7	+4.3	−1.7	+4.0	8.7	+2.1	−9.9	+0.4	12.8	+4.7	−3.4	+1.0
750	8.2	+4.1	−1.0	+4.4	7.9	+1.9	−9.4	+0.4	12.2	+4.3	−4.1	+0.7
1,000	7.7	+3.7	−0.4	+4.1	6.9	+1.7	−7.8	+0.6	11.4	+3.3	−3.8	+1.0
1,250	7.0	+3.2	−0.1	+3.8	5.7	+1.4	−7.0	+0.5	10.8	+3.0	−3.8	+1.1
1,500	6.2	+2.8	−0.7	+3.3	4.5	+1.1	−6.9	+0.6	10.4	+3.1	−4.4	+0.8
2,000	4.3	+2.2	−3.0	+2.3	2.2	+0.8	−7.5	+1.6	8.9	+3.2	−5.9	+0.1
2,500	1.6	+1.7	−6.1	+1.4	−0.1	+0.6	−9.6	+1.7	6.5	+3.0	−7.9	−0.3
3,000	−0.9	+1.7	−8.8	+1.1	−2.4	+0.4	−12.5	+1.5	4.0	+2.9	−10.3	−0.5
3,500	−4.2	+1.0	−11.3	+1.0	−5.1	0.0	−15.6	+1.3	1.4	+2.9	−13.6	−1.3
4,000	−8.0	+0.2	−14.7	+0.3	−9.7	−1.2	−18.2	+1.2	−1.4	+2.8	.....	.....
4,500	−11.6	0.0	−17.4	+0.6	−13.2	−1.5	−20.5	+1.3	−4.3	+2.8	.....	.....
5,000	.....	.....	.....	.....	−16.5	−1.9	.....	.....	−7.6	+3.0	.....	.....

RELATIVE HUMIDITY (PER CENT).

Surface	59	−11	76	−5	63	−3	89	+7	70	−7	81	+2
250	59	−11	.....	.....	62	−4	.....	.....	69	−7	81	+2
500	55	−9	73	−5	55	−7	87	+7	67	−7	78	+4
750	52	−7	66	−6	52	−7	78	+5	64	−6	73	+3
1,000	49	−5	59	−7	49	−7	67	+2	61	−3	66	+2
1,250	45	−5	55	−7	48	−9	60	+1	59	−1	62	+3
1,500	41	−5	55	−4	46	−11	56	−1	57	0	60	+5
2,000	35	−6	54	−3	42	−10	53	−3	54	+2	56	+7
2,500	33	−6	56	0	37	−13	54	−2	52	+2	64	+14
3,000	32	−5	54	−2	35	−13	55	−1	50	+3	61	+10
3,500	30	−7	51	−3	38	−11	46	−7	48	+3	72	+16
4,000	30	−4	50	−3	40	−9	40	−11	46	+5	.....	.....
4,500	30	−4	46	−7	40	−9	57	00	44	+5	.....	.....
5,000	.....	.....	.....	.....	40	−9	.....	.....	43	+5	.....	.....

VAPOR PRESSURE (*mb.*).

Surface	7.10	+0.62	3.92	+0.48	7.44	+0.10	2.55	+0.06	11.23	+1.78	4.38	+0.32
250	7.07	+0.64	.....	.....	7.35	+0.12	.....	.....	11.04	+1.96	3.52	−0.44
500	6.47	+0.79	3.82	+0.54	6.53	+0.10	2.51	+0.05	10.47	+2.04	2.94	−0.53
750	5.90	+0.79	3.56	+0.58	5.84	−0.10	2.23	−0.02	9.51	+1.74	2.48	−0.66
1,000	5.41	+0.83	3.26	+0.44	5.19	−0.34	2.06	−0.10	8.51	+1.52	2.14	−0.71
1,250	4.77	+0.64	3.10	+0.43	4.67	−0.37	1.90	−0.17	7.89	+1.54	1.93	−0.65
1,500	4.05	+0.41	2.98	+0.46	4.06	−0.52	1.82	−0.13	7.44	+1.66	1.73	−0.61
2,000	2.93	−0.01	2.44	+0.24	3.04	−0.66	1.64	−0.07	6.24	+1.54	1.18	−0.70
2,500	2.16	−0.24	1.91	+0.06	2.07	−0.91	1.38	−0.02	5.31	+1.40	0.95	−0.73
3,000	1.75	−0.22	1.55	−0.01	1.59	−0.87	1.07	−0.02	4.40	+1.21	0.59	−0.88
3,500	1.30	−0.41	1.11	−0.17	1.34	−0.76	0.57	−0.20	3.78	+1.15	0.39	−0.92
4,000	0.93	−0.40	0.56	−0.46	1.02	−0.77	0.33	−0.20	3.29	+1.21	.....	.....
4,500	0.69	−0.47	0.18	−0.64	0.90	−0.75	0.90	+0.18	2.91	+1.14	.....	.....
5,000	.....	.....	.....	.....	0.82	−0.73	.....	.....	2.60	+1.11	.....	.....

TABLE 2.—*Free air, resultant winds, m. p. s. during January, 1923.*

Altitude, m. s. l. (*m.*)	Broken Arrow, Okla. (233*m.*)				Drexel, Nebr. (396*m.*)				Due West, S. C. (217*m.*)				Ellendale, N. Dak. (444*m.*)				Groesbeck, Tex. (141*m.*)				Royal Center, Ind. (225*m.*)			
	Mean.		5-year mean.		Mean.		8-year mean.		Mean.		2-year mean.		Mean.		6-year mean.		Mean.		5-year mean.		Mean.		5-year mean.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 31° W.	2.6	S. 35° W.	1.1	N. 36° W.	1.2	N. 86° W.	1.4	S. 84° W.	2.8	N. 84° W.	1.4	N. 34° W.	1.8	N. 56° W.	2.9	S. 17° W.	2.8	N. 40° W.	0.4	S. 51° W.	1.8	S. 51° W.	2.1
250	S. 30° W.	2.7	S. 31° W.	1.3	.....	.....	.....	.....	S. 82° W.	3.1	N. 86° W.	1.7	.....	.....	.....	.....	S. 19° W.	3.7	N. 63° W.	0.3	S. 51° W.	1.9	S. 51° W.	2.4
500	S. 35° W.	3.7	S. 26° W.	2.3	N. 85° W.	2.1	N. 81° W.	2.4	S. 84° W.	5.5	W.	3.4	N. 40° W.	1.8	N. 58° W.	3.3	S. 29° W.	5.9	S. 58° W.	1.3	S. 57° W.	4.1	S. 59° W.	4.4
750	S. 48° W.	4.0	S. 32° W.	3.3	N. 88° W.	4.2	N. 75° W.	4.2	S. 89° W.	7.4	S. 89° W.	5.1	N. 70° W.	2.3	N. 61° W.	4.9	S. 41° W.	7.0	S. 62° W.	2.5	S. 72° W.	6.2	S. 67° W.	6.6
1,000	S. 58° W.	4.6	S. 46° W.	3.6	N. 81° W.	5.1	N. 75° W.	5.5	S. 88° W.	8.8	S. 87° W.	6.1	N. 31° W.	2.9	N. 64° W.	6.1	S. 46° W.	7.5	S. 62° W.	3.4	S. 80° W.	7.4	S. 77° W.	7.5
1,250	S. 74° W.	4.9	S. 61° W.	3.9	N. 79° W.	6.5	N. 75° W.	6.7	N. 88° W.	10.7	N. 84° W.	8.2	N. 36° W.	3.7	N. 66° W.	7.2	S. 54° W.	8.5	S. 71° W.	4.6	S. 82° W.	9.0	S. 81° W.	8.9
1,500	S. 82° W.	5.2	S. 59° W.	4.9	N. 75° W.	8.9	N. 73° W.	8.2	N. 86° W.	12.5	W.	9.6	N. 35° W.	5.5	N. 66° W.	7.7	S. 52° W.	9.8	S. 74° W.	5.8	S. 82° W.	10.2	S. 85° W.	10.0
2,000	W.	6.9	S. 73° W.	7.0	N. 74° W.	11.2	N. 73° W.	10.5	N. 82° W.	15.2	N. 84° W.	12.0	N. 77° W.	8.8	N. 67° W.	10.1	S. 64° W.	9.3	S. 78° W.	7.4	S. 78° W.	11.4	S. 84° W.	12.0
2,500	S. 86° W.	8.9	S. 82° W.	8.6	N. 81° W.	14.3	N. 79° W.	12.6	N. 86° W.	17.4	N. 85° W.	15.0	N. 76° W.	12.5	N. 66° W.	12.4	S. 75° W.	9.0	S. 80° W.	8.4	N. 88° W.	15.2	W.	14.3
3,000	N. 80° W.	9.1	N. 86° W.	10.4	S. 89° W.	16.0	N. 79° W.	14.4	S. 80° W.	16.7	N. 89° W.	16.5	N. 86° W.	13.0	N. 69° W.	14.0	S. 82° W.	8.8	S. 81° W.	9.8	S. 79° W.	15.8	S. 88° W.	14.2
3,500	W.	10.1	N. 86° W.	10.6	S. 78° W.	16.6	N. 80° W.	15.3	S. 80° W.	15.3	W.	16.2	N. 79° W.	13.6	N. 69° W.	15.1	S. 80° W.	8.9	S. 88° W.	10.4	S. 61° W.	14.0	S. 80° W.	13.3
4,000	S. 80° W.	15.5	S. 86° W.	15.5	S. 68° W.	17.0	N. 88° W.	16.9	S. 85° W.	15.5	N. 83° W.	15.8	N. 68° W.	16.4	N. 60° W.	16.8	W.	11.9	S. 80° W.	11.6	W.	19.7	S. 73° W.	17.7
4,500	W.	10.9	S. 77° W.	13.3	.....	.....	.....	.....	S. 79° W.	16.9	N. 83° W.	15.3	N. 59° W.	18.9	N. 52° W.	19.0	N. 74° W.	12.6	S. 80° W.	12.3	.....	.....	.....	.....
5,000	.....	.....	.....	.....	.....	.....	.....	.....	N. 68° W.	18.6	N. 57° W.	17.8	.....	.....	.....	.....	N. 74° W.	13.6	N. 88° W.	14.5	.....	.....	.....	.....